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Very few health scholars and professionals, and fewer still in health education, would have encountered during their academic or professional preparation any of the concepts, principles, or methodologies of what is now called “systems science.” Characterized by analytic approaches that accommodate, for example, nonlinear relationships, bidirectional feedback loops, and time-delayed effects, systems science is concerned with how we understand and act effectively within complex systems. With such a broad purview, the very notion of systems science itself often raises puzzling questions about its scope, depth, and potential value for health promotion and public health work. Thus, it may seem surprising that within just a few month’s notice, more than 40 teams of investigators responded to a call for papers on “Systems Science Applications in Health Promotion and Public Health” that *Health Education & Behavior (HE&B)* issued in March 2012.

Systems science has intellectual origins in general systems theory and research dating back to the 1930s. Often associated with the seminal work of the Austrian biologist Ludwig von Bertalanffy, there are in fact scores of other strands of inquiry that have combined and complemented one another to yield what is now a phenomenally rich space of thinking and practice (International Institute for General Systems Studies, 2001; von Bertalanffy, 1968; Weckowicz, 1989). Studies using a systems perspective have opened important frontiers in disciplines such as anthropology, biology, psychology, and the social sciences, as well as in applied sciences such as cybernetics, engineering, medicine, and public health, where applications anchored in a systems view have become increasingly prominent (Institute for Systems Biology, 2012; Milstein, 2008; Richardson, 1991).

Interest in systems science and its implications for improving public health has been building for several decades. This wave of interest stems in large part from the growing recognition that traditional research methods in the behavioral and social sciences, which typically feature narrow problem definitions and linear analytic representations, are by themselves insufficient to adequately address the complexity of the most pressing population health challenges

(Livingood et al., 2011; Mabry, Marcus, Clark, Leischow, & Mendez, 2010; Sterman, 2006). Systems science offers a complementary approach, capable of addressing more complex, interactive phenomena, while also attending to the practical constraints and opportunities that shape the contours of the social, physical, and organizational settings in which responses to those health challenges must occur (Leischow & Milstein, 2006; Luke & Stamatakis, 2012; Mabry, Olster, Morgan, & Abrams, 2008).

Both governmental and nongovernmental health agencies, including the National Institutes of Health (NIH), Centers for Disease Control and Prevention, the Institute of Medicine, and many others, have formally acknowledged the value of systems science (Best, Clark, Leischow, & Trochim, 2007; Gerberding, 2005; Hussey et al., 2013; Institute of Medicine, 2012; Mabry et al., 2008; Milstein, 2008; NIH Office of Behavioral and Social Sciences Research, 2013). Accordingly, investments in understanding the potential of systems science and its applications to public health problems have been growing through a widening array of funded research and training programs (Mabry & Kaplan, 2013). Several of the authors whose work is published in this supplement, in fact, were recipients of those investments, and their pioneering work has already begun to enhance programs and policies such that the public may be the ultimate beneficiaries of those investments.

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Recognizing the opportunity to showcase and disseminate the growing portfolio of work on systems science in health promotion and public health, this supplemental issue of *HE&B* was sponsored by four entities of the NIH, all with a practical stake in harnessing the potential of systems science. Each has embraced systems science as a tool for research. These include the NIH Office of Behavioral and Social Sciences Research (OBSSR), the National Institute on Aging (NIA), the National Cancer Institute (NCI), the National Dental and Craniofacial Institute (NIDCR), and the Fogarty International Center (FIC).

The corpus that comprises this supplement includes 11 articles that successfully completed a blinded, multistage peer-review with both topical subject matter and methodological reviewers assigned to evaluate each manuscript. Final selections were made by the Guest Co-Editors (PLM and BM) in conjunction with members of the Guest Editorial Board (including WCL) and both the journal's Editor-in-Chief (JPA) and Associate Editor (AFA) in charge of the supplement.

The call for papers sought examples of work that demonstrates how systems science methods have been used to engage practical challenges and opportunities within real-world organizational settings. It was gratifying to see exemplary work spanning a wide range of health frontiers using a diverse mix of methodologies. Of course, neither a single study nor even a small collection of studies like this one can represent the whole of such a diverse field. However, the articles published here illustrate how several well-established techniques can open new avenues for understanding and action.

Four investigator teams report on their uses of network analysis. Schaefer, Adams, and Haas (2013) examined individual-level connections, focusing on patterns of adolescent smoking and then went a step further to develop a stochastic actor-based model. Luke, Wald, Carothers, Bach, and Harris (2013); Retrum, Chapman, and Varda (2013); and Yessis, Riley, Stockton, Brodovsky, and Von Sychowski (2013) studied organizational structures that, respectively, accelerate the dissemination of evidence-based guidelines for tobacco control, predict trust and resource exchange among public health collaboratives, and encourage local and regional organizations to participate in multilevel, community interventions to reduce obesity.

Hekler et al. (2013) used system identification modeling to investigate which components of a physical activity intervention lead to long-term maintenance.

Two teams used system dynamics simulation modeling. Weeks et al. (2013) developed a conceptual map with many feedback processes, to better understand the dynamic context for HIV and sexually transmitted infection transmission among Chinese sex workers, and Wakeland et al. (2013) used a system dynamics model to simulate overdose deaths due to pharmaceutical opioids in the United States and the likely impact of three different educational interventions.

Agent-based modeling provides the basis for two additional studies. Yonas et al. (2013) used an agent-based model

to explore interventions targeting high-crime neighborhoods and the potential unintended consequence of moving crime to adjacent communities, whereas Tian, Osgood, Al-Azem, and Hoeppner (2013) developed simulated scenarios to study the likely impact of different contact-tracing regimens and subsequent intervention on tuberculosis trends in Saskatchewan.

Metcalfe et al. (2013) developed both system dynamics and agent-based models to examine the long-term performance of oral health programs, while also recognizing the social networks and geographic position of older adult participants. Finally, Ip et al. (2013) took a bird's-eye view of the field and addressed the pressing need to better align and combine statistical and system science techniques in public health research.

Taken together, this collection of articles opens a window on the growing volume, topical range, and methodological diversity of contemporary applications of systems science in public health. Our goal in publishing this supplement is to acquaint the readers of *HE&B* with the potential of systems science methodologies and to showcase an impressive cross section of previously funded studies. Thus, we expect this supplement will challenge research scientists, public health practitioners, professional preparation educators, and policymakers to explore opportunities for adopting and adapting systems science within their spheres of influence. Likewise, we believe both established and emerging scholars who see opportunities to use systems science will commit themselves to not only learn and master these techniques but also to advance the quality of these methodologies by engaging in dialogue, collaborative efforts, and a range of other activities to advance the field.

In 2006, Lawrence Green issued a plea to the systems science community

to help us get a handle on the multiplicity of influences at work in the real world of [public health] practice, so that the evidence from our study of interventions and programs can reflect that complex reality rather than mask it. (p. 406)

Now, almost a decade later, we ask ourselves, how well have we responded? We believe this supplement provides compelling evidence that systems science can indeed help untangle and embrace the complexity inherent in health promotion and public health research questions. However, there are vast opportunities to explore the systemic nature of public health challenges and those efforts are still relatively fragile; they require further cultivation through dedicated funding from federal agencies and others to support both methodological innovation and practical inquiry. Moreover, systems science is not routinely taught to incoming behavioral and social science researchers or to those in schools of public health. Thus, further investments and deeper involvement by the government, philanthropic, and academic leaders are necessary if we are to harness the potential of this interface between

systems science and public health practice in the ongoing quest to improve population health.

By publishing its first-ever supplement on systems science, *HE&B* signals its commitment to be a forum for further dialogue on this topic and to disseminate discoveries that advance this increasingly vital field of study.

Supplement Note

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